

# **VWAP and Optimal Execution**

**R. Scott Morris**

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# Presentation Overview

- What is VWAP?
- How Goldman Sachs has improved VWAP execution
- Why VWAP is a mediocre benchmark
- Optimal Execution – what the customer really wants
- Q & A

# What is VWAP?

- VWAP = Volume Weighted Average Price
- $VWAP = \frac{\sum (\text{trade price} * \text{quantity})}{\sum \text{quantity}}$
- Ex: For the three stock trades:
  - 100 shares at \$100.00;
  - 200 shares at \$100.50;
  - 300 shares at \$101.00;
  - $VWAP = \$100.67$

# Why is VWAP Important?

- The market VWAP provides a good reference price for an order's average execution price.
- Very Popular Benchmark:
  - Around 20% of US Volume
  - Over 33% of Japan Volume

# Goldman Sachs' VWAP Product

- Built from The Hull Group's automated market making techniques and order placement logic
- Designed to sneak under the market's radar by executing many small transactions
- Goal is to "meet" VWAP with small variance, not "beat" it

# Problems with VWAP

- **Beating VWAP does not mean getting a superior execution** – Ultimately, customers care about price. They would prefer missing VWAP with minimum price impact versus beating VWAP at a less attractive price. Keyword: Implementation Shortfall.
- **A VWAP execution does not account for the cost of delayed execution** – Risk adverse investors may be willing to pay up, in market impact, for immediacy.
- Each investor has his or her own risk / reward preference; VWAP does not measure this trade-off.

# Optimal Execution

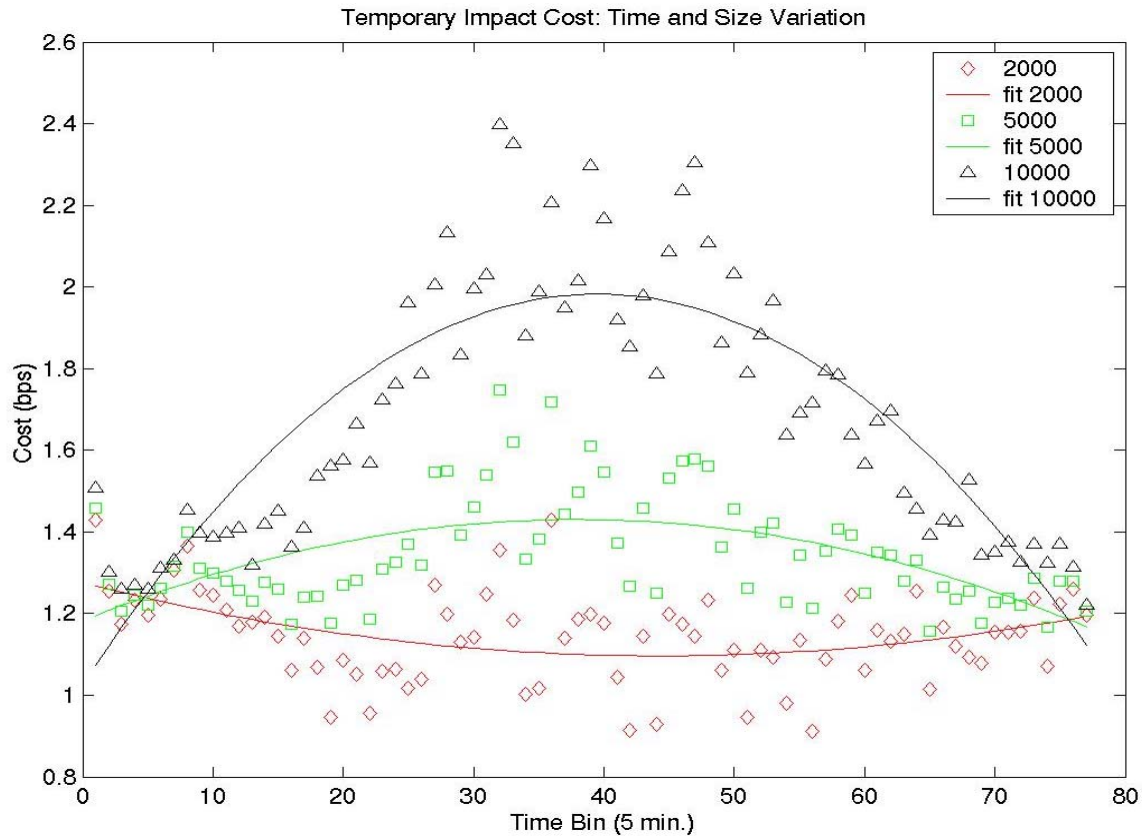
- **Optimal Execution quantifies the trade off between market impact and execution risk subject to a customer's risk preference and order time horizon.**

# Optimal Execution – Market Impact

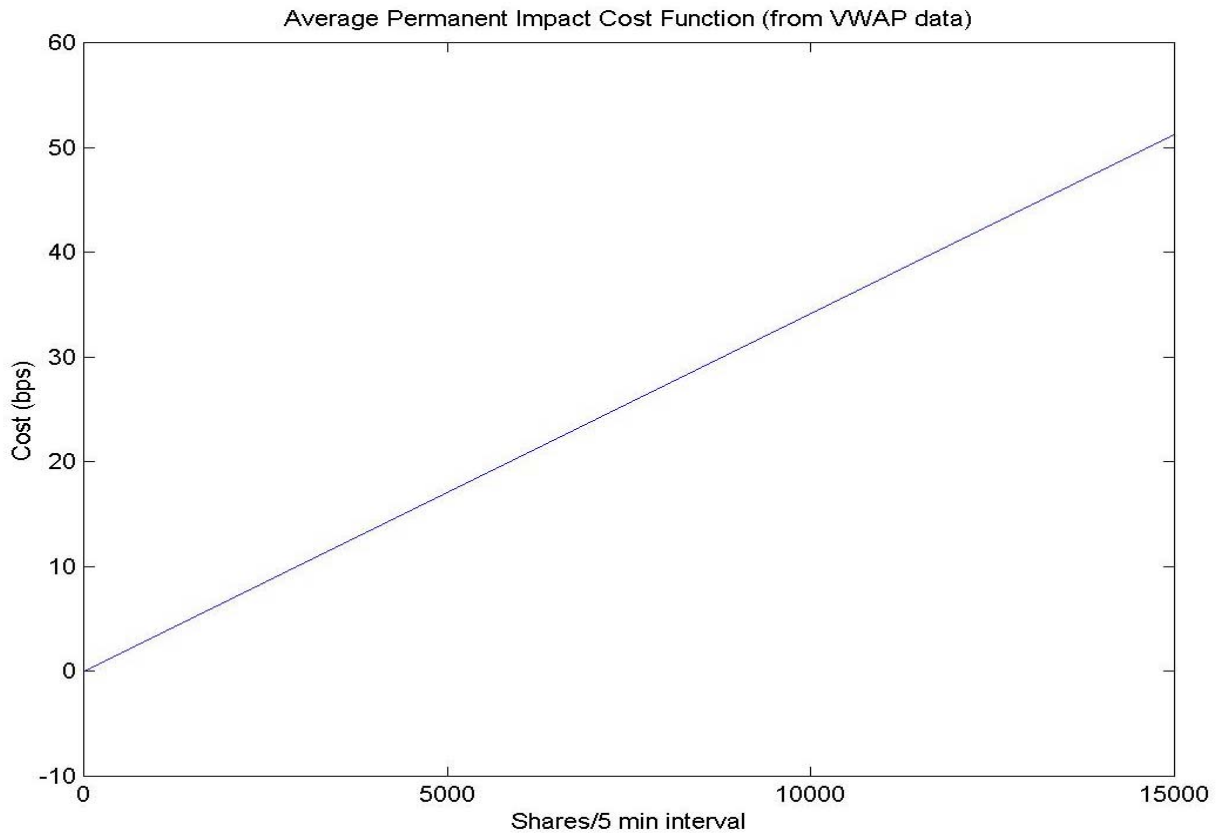
- **Market Impact** is the amount that the price moves between the time the order is placed and execution is complete. It has two components:
  - **Temporary** – the cost of seeking immediate liquidity
  - **Permanent** – the difference between the pre-trade and the post-trade equilibrium price.
- Both are important for cost minimization function



# Optimal Execution – Temporary Impact



# Optimal Execution – Permanent Impact



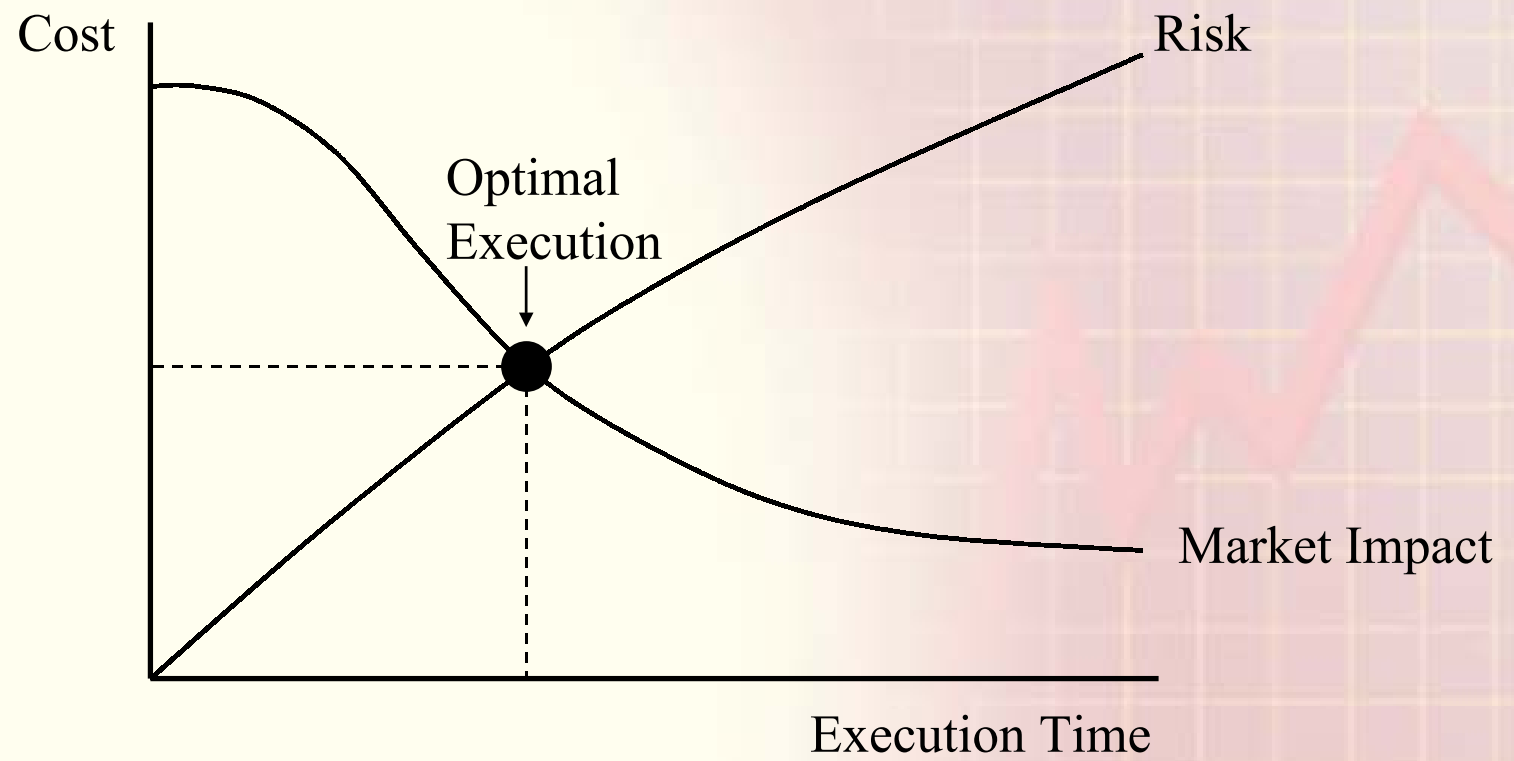
# Optimal Execution - Execution Risk

**Execution Risk** is the cost of delayed execution in terms of possible stock price movement



Courtesy of George Sofianos

# Optimal Execution - Solution



# Optimal Execution – Customer Preferences

- A Mean / Variance framework is used in the optimization process
- Customer Risk Preferences are used to determine the appropriate solution
- Stock specific alpha can be added as well

# Q & A

